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January 13, 2014

Mr. Roger Papler  
 San Francisco Bay Regional  
 Water Quality Control Board  
 1515 Clay Street, Suite 1500  
 Oakland, CA 94612

Ms. Melanie Morash  
 United States Environmental  
 Protection Agency Region 9  
 75 Hawthorne Street, Mail Code SFD-6-2  
 San Francisco, CA 94105

Dear Mr. Papler and Ms. Morash,

**Reference: Addendum to the February 17, 2012 Revised Work Plan for Indoor Air Testing  
 COE Study Area, Palo Alto, California**

Stantec Consulting Service Inc. (Stantec) has prepared this addendum to the February 12, 2013 *Revised Work Plan for Indoor Air Testing, COE Study Area, Palo Alto, California* (the Work Plan) on behalf of Hewlett-Packard Company (HP) and Varian Medical Systems (Varian). The Work Plan was prepared by Stantec for HP and Varian (collectively, "the Companies") to evaluate potential vapor intrusion in the California-Olive-Emerson (COE) Study Area in Palo Alto, California, and was previously approved with certain conditions by the Regional Water Quality Control (Water Board) and the United States Environmental Protection Agency (EPA – See approval letters dated March 12, 2012 and December 4, 2012). Indoor air testing was completed at 10 single-family homes or duplexes, 6 multi-family residential complexes and one commercial building under the Work Plan, as conditionally approved by the agencies. As reported to the building owners by EPA Region 9, the testing to date found no evidence of vapor intrusion to living spaces.

This Work Plan Addendum was prepared in response to discussions with EPA Region 9 representatives on September 12, October 30, and November 22, 2013 in which the agency advised HP and Varian of new requirements they seek to integrate into this ongoing investigation, as well as investigations at eight other National Priority List (NPL) sites in the South Bay Area. Specifically, this Work Plan Addendum includes the following.

- ☐ A modification to the project team.
- ☐ Reference to the new EPA Short-Term Response Action Levels (STRALs) and the related guidance.
- ☐ A procedure for testing air in commercial buildings after the heating ventilation and air conditioning (HVAC) system has been off for at least 36 hours.
- ☐ Re-testing of indoor air during cold-weather months (i.e., January and/or February), with concurrent crawlspace/basement testing, of the residential buildings that were sampled in 2012 during April or July and September.
- ☐ Methodology for collection of crawlspace/basement samples.
- ☐ Methodologies for collection and analysis of potential pathway grab samples.



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- Supplemental assessment, in a phased manner, of potential for vapor intrusion where buildings overlie lower concentration portions of the COE Area impacted groundwater plume.

These are further described below.

**Project Team Modification**

Section 1.2 of the Work Plan outlines the project team's roles and responsibilities, including RWQCB and EPA oversight for vapor intrusion. Since submittal and approval of the Work Plan, Ms. Melanie Morash has assumed the role of EPA Project Manager for the implementation of the work described in the Work Plan and this Work Plan Addendum.

**Field Sampling Plan Modifications**

Modifications applicable to Section 3.0 of the Work Plan, "Field Sampling Plan" follow.

Revisions to Short Term Action Levels (STRALs)

Section 4.0 of the Work Plan "Data Quality Assurance Project Plan" includes references to screening values for short-term (acute – 1 to 14 days, and intermediate – 14 to 364 days) trichloroethene (TCE) exposure. Short-term (and long-term, chronic) health-based screening values are described in Section 4.1 of the Work Plan, "Data Quality Standards" and summarized in Table 1 of the Work Plan. The short-term screening levels in the approved Work Plan were based on Agency for Toxic Substances & Disease Registry (ATSDR) Minimal Risk Levels.

In an Attachment to a letter to the Water Board dated December 3, 2013, EPA Region 9 provided a document titled *EPA Region 9 Guidelines and Supplemental Information Needed for Vapor Intrusion Evaluations at the South Bay National Priorities List (NPL) Sites*. This document, in Item #1, presents interim TCE indoor air STRALs and related information on application of the STRALs for residential and commercial buildings (Attached as Exhibit A). These TCE STRALs are now incorporated in this Work Plan Addendum by reference. The long-term health-based screening criteria for TCE and the screening values specified in Table 1 of the Work Plan for other chemicals of concern remain unchanged.

The results of time-integrated indoor air samples collected with the HVAC system operating normally from routinely occupied living or working spaces will be compared to the STRALs. If such results exceed the STRALs for TCE, HP and Varian will comply with the information provided by EPA for application of the STRALs, which is provided in Item #1 in the Attachment (Exhibit A to this Addendum).

Commercial Building Testing With HVAC System Off

In addition to collecting indoor air samples from commercial buildings as contemplated in the Work Plan, i.e., under normal HVAC operating conditions, indoor air samples will be collected from

Design with community in mind



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commercial buildings after the HVAC system has been off for at least 36 hours immediately prior to sampling, subject to the access issues noted below. The HVAC system will remain off throughout the HVAC system-off sample collection period. Collection of indoor air samples with the HVAC system off is intended to provide EPA additional data with which to evaluate possible soil gas transport into buildings and the results would not be considered representative of building indoor air quality under normal operating conditions. The California Energy Code (24 California Code of Regulations Part 6, § 100) as adopted by the City of Palo Alto Ordinance No. 5064 (2009) requires that normally occupied enclosed spaces in all new and existing commercial-use buildings must be ventilated naturally or mechanically at a continuous rate to promote occupant comfort and health.

HVAC system-off sampling will be conducted in commercial buildings where consent to conduct such sampling is granted by the property and building owner(s) and tenant(s) and where the tenant or building owner does not itself perform the testing requested by USEPA, as is expected at the two remaining on-site buildings. There may be buildings in the study area at which HVAC system-off sampling is not feasible (e.g. continuous use/occupancy) and/or authorization is not provided. Such instances will be brought to the attention of EPA and addressed on a case-by-case basis.

Sampling equipment and techniques are described in the Work Plan. HVAC system-off indoor air samples will be collected from approximately the same locations and height (approximately 3 to 5 feet above the floor - considered to represent the typical breathing zone of building occupants) as HVAC system-on samples. The general anticipated approach to completing the HVAC system-on/-off sampling is to collect samples with the HVAC system on during a Friday, and with the HVAC system off on the following Sunday, for example. The HVAC system would be turned off following the first round of sample collection, and remain off at least 36 hours prior to and during the re-sampling. Sample duration will be 10 hours unless adjusted based on consultation with EPA. All samples within a building will be collected concurrently during a given sampling event. Collection of outdoor/ambient air samples associated with commercial building sampling will generally begin approximately 1 to 2 hours prior to collection of indoor air samples; however, this may vary depending on the air exchange rate of the building. Outdoor/ambient sample collection start times for each building will be determined through consultation with EPA.

#### Grab Sample Collection

Air grab sample collection and analysis methodology is not addressed in the Work Plan. Grab sample results are not viewed as representative of indoor air concentrations. An air grab sample is collected over a few seconds or minutes, rather than over a defined extended time period (e.g., an 8-hour time-integrated sample collected using a flow regulator). During the course of previously-conducted indoor air sampling, EPA requested grab samples from locations thought to represent potential preferential pathways for vapor transport (e.g., elevator shafts) and/or locations identified during the building survey to be chemical storage areas. The following procedure, previously approved by EPA, will be used for collection of grab samples.

- ☐ Grab samples will be collected using individually certified 6-liter canisters without flow regulators.



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- For locations where safe access is not possible, such as elevator pits, an appropriate length of ¼-inch outside diameter Teflon® tubing, or equivalent, will be attached to the canister using compression fittings. The tubing will be lowered to the sample collection depth and the volume of dead air within the tubing will be removed using a gas-tight syringe.
- The canister valve will be opened and sampling continued until the canister reaches ambient conditions. The valve will then be closed and the appropriate information entered on the sample tag and the chain-of-custody form. Samples will be clearly identified as “grab samples” and assigned identification numbers based on methodology specified in the Work Plan.
- Grab samples will be submitted to the project laboratory for analysis of the chemicals of concern identified in the Work Plan (and chloroform) using EPA Method TO-15 SIM.

The results of grab sampling analysis are only appropriate for identifying potential indoor sources for chemicals of concern and routes of soil gas entry into a building. Grab sample results are not considered representative of indoor air quality and therefore are not appropriate for comparison to indoor air screening or action levels established for this project.

Residential Crawlspace/Basement Sample Collection

Crawlspace samples will be collected at residences where indoor air sampling is conducted, where crawlspaces exist and are reasonably accessible for sampling, and where appropriate permission and access is granted. The following procedure will be used as a guideline for the collection of crawlspace samples. Variations in procedure may be necessary based on the observed construction of a given crawlspace.

- As practical, crawlspace samples will be collected from beneath the central portion of the residence and away from obstructions such as ductwork, construction debris or foundation footings.
- Where safe ingress/egress through a crawlspace access located within the residence is provided, the sampling device will be placed within the crawlspace immediately below the access point.
- Where no access is provided from within the residence, an attempt will be made to place the Summa™ canister through existing openings in the crawlspace sidewalls. A rigid rod or similar tool may be used to position the sampling. Alternatively, an appropriate length of ¼-inch outside diameter Teflon® tubing, or equivalent, will be attached to the canister using compression fittings, and the tubing extended through a rigid pipe to the desired sampling location.
- Crawlspace samples will be collected concurrently, over the same duration and following the same procedures as indoor air samples.



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Where a basement is present, one indoor air sample will be collected from the approximate center of the basement and at a height considered to represent a normal breathing zone (3 to 5 feet above floor). The basement air sample will be collected over the same duration and following the same procedures as indoor air samples.

### **Cold Season Resampling of Residential Buildings**

As reported to the homeowners by EPA Region 9, the testing to date in this investigation did not detect vapor intrusion occurring in living spaces. EPA Region 9 now is requesting cold weather sampling in residential buildings to assist in evaluating possible temporal variability of indoor air testing results. If permission and access are granted, residential buildings that were previously sampled during April or July and September of 2012 will be resampled during January and/or February of 2014. Where access is granted, samples will be collected from approximately the same locations as previously collected samples using the same sampling procedures and equipment. If crawlspaces exist and are reasonably accessible for sampling and appropriate permission and access is granted, crawlspace samples will be concurrently collected at these residences.

Section 3.2.2.1 of the existing Work Plan describes the protocol that was approved by EPA Region 9 and the Water Board for the interactions with the residents and was successfully implemented in the residential testing that occurred in this investigation. EPA took the lead in interacting with residents about the testing and in explaining the results. We anticipate that EPA, with the support of Stantec, will continue its lead role in contacting residential property owners/occupants regarding the additional indoor air sampling, requesting permission to sample, and communicating results.

### **Supplemental Vapor Intrusion Assessment**

EPA Region 9 has recommended to the Water Board that phased approaches and standardized off-property TCE vapor intrusion study areas, among other recommendations, "be incorporated, as appropriate, into existing and future Vapor Intrusion Evaluation Work Plans" for nine South Bay sites. EPA Region 9 states, "Work Plans shall be prepared or revised, as appropriate, to define the Vapor Intrusion Off-Property Study Area as the area bounded by the estimated TCE shallow zone groundwater contamination area greater than 5 [microgram per liter or]  $\mu\text{g/L}$ ."

The vapor intrusion study area that EPA Region 9 and the Water Board had previously directed be assessed in this investigation is identified in Section 1.0 of the approved Work Plan and is defined by 100  $\mu\text{g/L}$  of TCE in groundwater for commercial use properties and 50  $\mu\text{g/L}$  for residential-use properties. As reported by EPA, vapor intrusion to living spaces has not been found in the testing conducted in these areas. In light of EPA Region 9's recommendation for standardized study areas among the South Bay TCE sites, including the COE Area, supplemental assessment of vapor intrusion potential will be conducted for buildings beyond the previously approved study area to areas where TCE from the Site is greater than 5  $\mu\text{g/L}$ . The activities to be conducted are intended to help assess whether there may be conditions in the COE Area such as buildings (particularly residences) that: are closer to source areas, have basements that are impacted by seasonally fluctuating groundwater levels, or have preferential pathways or other building-specific



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characteristics that might facilitate upward migration of subsurface vapors into interior living spaces.

The supplemental assessment activities that will be conducted in the next phase of this assessment consist of the following:

- ☐ Review of COE Area hydrogeological (e.g., depth to groundwater) and groundwater chemistry data.
- ☐ Review of COE Area indoor air testing data collected to date, along with cold season indoor air testing data to be collected during 2014.
- ☐ Visual observations of buildings to ascertain, to the extent practical from external observation, whether a given building likely has a basement or other potential preferential pathway of concern.

Information from these activities will be used to assess what, if any, additional actions may be warranted.

All other provisions of the Work Plan remain in effect.

Regards,

**STANTEC CONSULTING SERVICES INC.**

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Attachment: Exhibit A

cc: Annette Walton, Stanford  
Hazardous Materials Inspector, City of Palo Alto Fire Department  
Caleb Shaffer, EPA  
Kathleen Salyer, EPA

## **Exhibit A**



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**

**Region 9**

**75 Hawthorne Street  
San Francisco, CA 94105**

December 3, 2013

Stephen Hill, Chief  
Toxics Cleanup Division  
California Regional Water Quality Control Board – SF Bay Region  
1515 Clay Street #1400  
Oakland, CA 94612

**SUBJECT:** EPA Region 9 Guidelines and Supplemental Information Needed for Vapor Intrusion Evaluations at the South Bay National Priorities List (NPL) Sites

Dear Mr. Hill:

The United States Environmental Protection Agency (EPA) Region 9 appreciates the opportunity to work with the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) in conducting vapor intrusion evaluations at the following Regional Water Board-lead National Priorities List (NPL) or Superfund sites in the South San Francisco Bay Area (South Bay Sites) where trichloroethene (TCE) or tetrachloroethene (PCE) are contaminants of potential concern:

- AMD 901/902/TRW Microwave/Phillips and Offsite Operable Unit Combined Sites in Sunnyvale
- AMD 915 DeGuigne Drive Site in Sunnyvale
- Monolithic Memories Site (also known as AMD 1165/1175 Arques Avenue Site) in Sunnyvale
- Fairchild Semiconductor Site in South San Jose
- Hewlett Packard 620-640 Page Mill Road Site in Palo Alto
- Intersil/Siemens Site in Cupertino and Sunnyvale
- National Semiconductor Site (also known as Texas Instruments Site) in Sunnyvale
- Synertek Building 1 Site in Santa Clara
- Teledyne/Spectra-Physics Sites in Mountain View

EPA recognizes and appreciates all of the vapor intrusion work activities conducted to date at these sites. Pursuant to recent discussions with EPA Region 9, the Regional Water Board, and the potentially responsible party (PRP) representatives on planned upcoming vapor intrusion work activities, EPA



Region 9 is providing this letter to outline EPA's recommended TCE interim short-term indoor air response action levels and guidelines and clarify the use of California-modified indoor air screening levels that should be applied when assessing and responding to TCE and PCE subsurface vapor intrusion into indoor air.

In addition, this letter includes, as outlined in the Attachment, additional information and specific requirements for vapor intrusion evaluations for the South Bay Sites, consistent with the "multiple-lines-of-evidence" approach in EPA's 2013 Office of Solid Waste and Emergency Response (OSWER) *External Review Draft – Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air*. In reviewing the multiple lines of evidence that have been collected for the South Bay Sites, EPA Region 9 has identified data gaps that must be filled to fully evaluate the potential for vapor intrusion into buildings overlying the South Bay Sites' contamination.

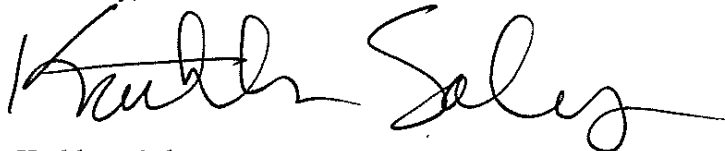
EPA Region 9 recommends that the following guidelines and supplemental information be incorporated, as appropriate, into existing and future Vapor Intrusion Evaluation Work Plans (Work Plans) for each of the South Bay Sites:

- Interim TCE Indoor Air Short-term Response Action Levels and Guidelines
- PCE Indoor Air Screening Levels
- Residential Building Sampling Approach – Multiple Rounds of Sampling including Colder Weather and Crawlspace Sampling
- Commercial Building Sampling Approach – Building Ventilation System (HVAC)-Off, HVAC-On and Pathway Sampling
- On-Property Study Area Building Sampling
- Phased Approach and Clarification of Vapor Intrusion Off-Property Study Areas to Include Buildings Overlying 5 µg/L TCE Shallow-Zone Groundwater Contamination

EPA Region 9 will continue to provide technical vapor intrusion and community involvement and outreach support for the South Bay Sites.

If you have any technical questions, please contact Melanie Morash of my staff at (415) 972-3050 or by e-mail to [morash.melanie@epa.gov](mailto:morash.melanie@epa.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "Kathleen Salyer", written in a cursive style.

Kathleen Salyer  
Assistant Director, Superfund Division  
California Site Cleanup Branch

Attachment: EPA Region 9 Guidelines and Supplemental Information for VI Evaluations

## **Attachment: EPA Region 9 Guidelines and Supplemental Information Needed for Vapor Intrusion Evaluations at the South Bay National Priorities List (NPL) Sites**

EPA Region 9 recommends that the following guidelines and supplemental information be incorporated, as appropriate, into existing and future Vapor Intrusion Evaluation Work Plans (Work Plans) for each of the South Bay NPL Sites, primarily with subsurface trichloroethene (TCE) and tetrachlorethene (PCE) contamination.

The additional information and specific requirements requested are consistent with the “multiple-lines-of-evidence” approach in EPA’s 2013 Office of Solid Waste and Emergency Response (OSWER) *External Review Draft – Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air*.

In reviewing the multiple lines of evidence that have been collected for the South Bay Sites, EPA Region 9 has identified data gaps that must be filled in order to fully evaluate the potential for vapor intrusion into buildings overlying the subsurface contamination at each individual South Bay Site.

### **Item #1 – Interim TCE Indoor Air Short-term Response Action Levels and Guidelines**

In September 2011, EPA published its *Toxicological Review of Trichloroethylene in Support of the Integrated Risk Information System (IRIS)*. Recent findings on TCE conclude that women in the first trimester of pregnancy are one of the most sensitive populations to TCE short-term inhalation exposure due to the potential for heart malformation for the developing fetus.

EPA uses a level of concern for non-cancer effects as a ratio of the exposure concentration to a safe dose including an additional margin of safety, called a reference concentration (RfC). This ratio is defined as a Hazard Quotient and abbreviated “HQ”. The IRIS assessment derived an inhalation RfC for continuous inhalation exposure to TCE, which is 2 micrograms per cubic meter (2  $\mu\text{g}/\text{m}^3$ ).

Because this is a developmental effect, the critical period for exposure is considered to be within an approximate 3-week period in the first trimester of pregnancy during which the heart develops. Scientific information on the exact critical period of exposure for this health impact is not currently available; however, general risk assessment guidelines for developmental effects indicate that exposures over a period as limited as 24 hours<sup>1</sup> may be of concern for some developmental toxicants.

In light of this RfC information, EPA Region 9 is using health protective response action levels and guidelines to address short-term inhalation exposures to TCE in indoor air from the subsurface vapor intrusion pathway. The purpose of these interim response action levels and guidelines is to be protective of one of the most sensitive and vulnerable populations, women in their first trimester of pregnancy, because of the potential for cardiac malformations to the developing fetus during this short timeframe.

These guidelines identify women of reproductive age as the sensitive population of concern, rather than only pregnant women, because some women may not be aware of their pregnancy during the first trimester.

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<sup>1</sup> U.S. EPA. Guidelines for Developmental Toxicity Risk Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/600/FR-91/001, 1991

**Assessment of TCE Inhalation Vapor Intrusion Exposure and Prompt Response Actions in Residential and Commercial/Industrial Buildings:** The interim TCE indoor air short-term response action levels should be included in Vapor Intrusion Evaluation Work Plans (Work Plans) for assessing and responding to inhalation exposures to TCE in residential and commercial buildings caused by subsurface vapor intrusion at the South Bay Sites.

<b>Interim TCE Indoor Air Short-Term Response Action Levels Residential and Commercial TCE Inhalation Exposure from Subsurface Vapor Intrusion South Bay NPL Sites</b>	
<b><i>Exposure Scenario</i></b>	<b><i>Prompt Response Action Level (HQ=1)<sup>2</sup></i></b>
Residential *	2 µg/m <sup>3</sup>
Commercial/Industrial 8-hour workday	9 µg/m <sup>3</sup>
10-hour workday (South Bay Sites) **	7 µg/m <sup>3</sup>
<p>* The Residential HQ=1 prompt response action level is equivalent to the inhalation reference concentration (RfC) since exposure is assumed to occur continuously over a 24-hour period.</p> <p>** Commercial/Industrial prompt response action levels are calculated as the time-weighted average from the RfC - 9 µg/m<sup>3</sup> for an 8-hour workday; 7 µg/m<sup>3</sup> for a 10-hour workday. Based on input from commercial building owners and tenants, EPA Region 9 recommends use of the 10-hour workday for determining the appropriate response action levels for commercial/industrial buildings at the South Bay Sites. Time-weighted adjustments can be made as needed for workplaces with longer work schedules.</p> <p>Note: These prompt response action levels are near the lower end of the Superfund Health Protective Cancer Risk Range;<sup>3</sup> thus, the Superfund Health Protective Risk Range for both long-term and short-term exposures is: 0.4 – 2 µg/m<sup>3</sup> for residential exposures and 3 – 9 µg/m<sup>3</sup> for 8-hour/day commercial/industrial exposures.<sup>4</sup></p>	

**TCE Indoor Air Concentration > Prompt Response Action Level (HQ=1):** In the event the indoor air TCE concentration related to subsurface vapor intrusion is detected above the prompt response action levels (HQ=1), then interim mitigation measures should be evaluated and implemented quickly, and their effectiveness (defined as a reduction of the TCE indoor air concentration to below HQ=1 level) confirmed promptly (e.g., all actions completed and confirmed within a few weeks).

<sup>2</sup> There is a need to identify TCE exposures that exceed the HQ=1 level by a magnitude sufficient enough that a more urgent response is prudent; it is EPA Region 9 practice to take immediate action to address exposures at or above an HQ=3 level.

<sup>3</sup> For cancer causing chemicals, the Superfund Health Protective Risk Range encompasses the range of concentrations EPA considers to be protective, from 1 to 100 in a million increased lifetime cancer risk. The level that falls into the most protective end of the risk range – 1 in a million increased lifetime risk – is what is used as the screening level for any particular chemical. After identifying the health protective levels, EPA then compares measured values to the lowest, most health-protective, end of the range. Although levels of exposure anywhere within the range may be acceptable, EPA's goal for indoor air exposures to Superfund site-related chemicals is to keep exposures as low as reasonably possible within the Superfund Health Protective Risk Range.

<sup>4</sup> U.S. EPA Region 9 May 2013 Regional Screening Levels: <http://www.epa.gov/region9/superfund/prg/> Accessed November 2013.

**Implementation of Interim Measures to Mitigate TCE Short-term Exposure:** The following interim response actions (mitigation measures) should be considered along with how quickly they can be implemented to reduce exposure to below the TCE short-term response action levels:

- Increasing building pressurization and/or ventilation mechanically with fans or the building ventilation system by increasing outdoor air intake
- Installing and operating engineered, sub-floor exposure controls (sub-slab and/or crawlspace depressurization; or in some cases a soil vapor extraction system)
- Eliminating exposure by temporary relocation, which may be indicated when immediate response actions are warranted.

The following interim measures may also be considered, but may have limited effectiveness and require additional monitoring to verify their effectiveness:

- Sealing and/or ventilating potential conduits where vapors may be entering building
- Treating indoor air (carbon filtration, air purifiers)

## **Item #2 – PCE Indoor Air Screening Levels**

EPA acknowledges that the California-modified indoor air screening levels for PCE differ from EPA's May 2013 Regional Screening Levels (RSLs) for PCE. EPA Region 9 would like to clarify that the California EPA Office of Health Hazard Assessment's PCE toxicity value should be used for all NPL sites within California, which includes the South Bay Sites.

Work Plans and reports should be prepared or revised, as appropriate, to evaluate indoor air sampling results using the California-modified indoor air screening level of  $0.4 \mu\text{g}/\text{m}^3$  for residential exposures and  $2 \mu\text{g}/\text{m}^3$  for commercial/industrial exposures. The Superfund Health Protective Risk Range for PCE is bounded by the  $10^{-6}$  excess cancer risk (low end) and by the non-cancer  $\text{HQ}=1$  (high end). Specifically, the Superfund Health Protective Risk Range for PCE is  $0.4 - 40 \mu\text{g}/\text{m}^3$  for residential exposures and  $2-180 \mu\text{g}/\text{m}^3$  for commercial/ industrial exposures.

## **Item #3 – Residential Building Sampling Approach – Multiple Rounds of Sampling including Colder Weather and Crawlspace Sampling**

Recognizing the temporal and spatial variability of indoor air and subsurface concentrations, EPA generally recommends collecting more than one round of sampling and from multiple locations. In reviewing the multiple lines of evidence that have been collected for the South Bay Sites, EPA Region 9 has identified several data gaps that must be filled in order to complete the vapor intrusion evaluations at each site. Specifically, it appears that multiple rounds of indoor air sampling have not been collected. For some sites, sampling has not been conducted during colder weather months, nor have samples been collected from crawlspaces or basements, where such are present in buildings.

Research studies<sup>5678</sup> have demonstrated that daily indoor air concentrations resulting from subsurface vapor intrusion can vary by two or more orders of magnitude in residential, passively ventilated structures. These studies also indicate that the highest indoor air concentrations usually occur when outdoor air temperatures are significantly lower than indoor air temperatures. Empirical indoor air data collected at passively ventilated buildings in the San Francisco Bay Area where multiple samples were collected indicate TCE indoor air concentrations from vapor intrusion up to two-to-three times higher during the colder months.

Work Plans should be revised to incorporate multiple rounds of sampling, including sampling during colder weather months (November through February, with January generally being the coldest month in the Bay Area), to assess the potential variability of indoor air contaminant concentrations during conditions when the potential for vapor intrusion may be higher. In addition, crawlspace, basement, and pathway sampling should be included, as appropriate, as part of the vapor intrusion investigation.

Finally, EPA Region 9 supports the use of longer-term passive samplers to help assess the temporal variability of indoor air vapor intrusion-related contaminant concentrations. The longer-term sampler provides a greater duration over which to average indoor air vapor intrusion levels for the purposes of completing the vapor intrusion evaluation, however EPA Region 9 is open to discussing sampling strategies for both the passive sampler and TO-15 canister.

#### **Item #4 – Commercial Building Sampling Approach - Building Ventilation System (HVAC)-Off, HVAC-On and Pathway Sampling**

Consistent with the multiple-lines-of-evidence approach recommended by EPA guidance, ongoing vapor intrusion evaluations at certain commercial buildings associated with some of the South Bay Sites have included soil gas, sub-slab soil gas, and/or potential preferential pathway sampling (such as near bathroom floor drains and from elevator shafts or mechanical rooms), as well as indoor air sampling during normal business hours with the building's heating, ventilation, and air conditioning (HVAC) systems operating.

In reviewing these lines of evidence, EPA Region 9 has identified as a data gap the lack of HVAC-off sampling for certain commercial buildings, and recommends that pathway sampling, where such sampling has not yet been conducted, be included in the multiple-lines-of-evidence evaluation.

Because EPA needs to evaluate the potential for subsurface vapor intrusion into buildings without reliance on the indoor air ventilation system and understand the full range of possible exposure scenarios, Work Plans must be prepared or revised, as appropriate, to include indoor air sampling with the building ventilation systems turned off in addition to sampling commercial buildings under current

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<sup>5</sup> Schumacher, B., R. Truesdale, and C. Lutes. Fluctuation of Indoor Radon and VOC Concentrations due to Seasonal Variations. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R/12/673, 2012

<sup>6</sup> Schumacher, B. and J. Zimmerman, U.S. EPA ORD, C. Lutes, ARCADIS, and R. Truesdale, RTI International. Indoor Air and Soil Gas Temporal Variability Effects on Sampling Strategies: Evidence from Controlled and Uncontrolled Conditions in an Indianapolis duplex. March 18, 2013 Association for Environmental Health and Sciences Foundation Conference: <https://iavi.rti.org/WorkshopsAndConferences.cfm>

<sup>7</sup> Johnson, P. Arizona State University. Multi-Year Monitoring of a House Over a Dilute CHC Plume: Implications for Pathway Assessment using Indoor Air Sampling and Forced Under-Pressurization Tests. March 18, 2013 Association for Environmental Health and Sciences Foundation Conference: <https://iavi.rti.org/WorkshopsAndConferences.cfm>

<sup>8</sup> Holton, C., H. Luo, Y. Guo, and P. Johnson, Arizona State University, K. Gorder and E. Dettenmaier, Hill Air Force Base. Long-term and Short-term Variation of Indoor Air Concentration at a Vapor Intrusion Study Site. March 22, 2012 Association for Environmental Health and Sciences Foundation Conference: <https://iavi.rti.org/WorkshopsAndConferences.cfm>

building operating conditions.

For HVAC-off sampling, sampling duration should begin a minimum of 36 hours following shut-down of the building ventilation systems (no outdoor air intakes into the building) and continue while HVAC systems remain off. Because there is a greater potential for elevated indoor air contaminant concentrations while the building ventilation is turned off, adequate notice must be provided to building management and potential occupants about the testing and the schedule for when the ventilation system will be shut off.

#### **Item #5 – On-Property Study Area Building Sampling**

At certain of the South Bay Sites, indoor air sampling was originally not required at specific On-Property Study Area (or former source area) commercial buildings that were thought to have a low potential for vapor intrusion (e.g., due to the presence of a vapor intrusion mitigation system such as a sub-floor vapor barrier or where living or workspaces are located above a ventilated underground parking garage).

However, vapor intrusion sampling has shown the potential for vapor intrusion to occur at buildings with existing vapor intrusion mitigation systems (for example, where the systems were damaged during building construction or renovation activities). For buildings overlying subterranean parking garages, preferential pathways such as elevator shafts and stairwells may also increase vapor intrusion potential into occupied living spaces.

EPA Region 9 would like to clarify that all On-Property Study Area buildings should be evaluated and sampled. For building space overlying subterranean parking, potential preferential pathways into the building indoor air space, such as elevator shafts and stairwells, should be evaluated.

Work Plans should be prepared or revised, as appropriate, to include pre-sampling walk-throughs to assess building and system conditions. These building surveys should identify if there are any conditions that may prompt any additional evaluation and sampling to assess the effectiveness of the vapor intrusion engineering controls of the buildings.

#### **Item #6 – Phased Approach and Clarification of Vapor Intrusion Off-Property Study Areas to Include Buildings Overlying 5 µg/L TCE Shallow-Zone Groundwater Contamination**

EPA supports the initial agreed upon prioritization of conducting vapor intrusion evaluations at commercial and residential buildings overlying higher TCE shallow A-zone groundwater contamination (greater than 50 µg/L for residential buildings and greater than 100 µg/L for commercial buildings). For those South Bay Sites where vapor intrusion evaluations have already begun, early project planning discussions culminated in a phased approach to delineating the Vapor Intrusion Off-Property Study Area, beginning with investigations in these higher concentration areas of the subsurface groundwater plumes.

The groundwater contamination at the South Bay Sites is generally very shallow, ranging between approximately 5 feet below ground surface (bgs) to 35 feet bgs. Ongoing data collection efforts at other similar vapor intrusion sites in Region 9, as well as nationally, have shown vapor intrusion potential into buildings overlying lower groundwater TCE concentrations (less than 50 µg/L for residential buildings and less than 100 parts µg/L for commercial buildings), at levels exceeding health protective indoor air levels. Factors include, but are not limited to, location relative to source areas,

impacts due to seasonal fluctuations in groundwater levels, preferential pathways into a building and other building-specific characteristics that facilitate upward migration of subsurface vapors into interior living and work spaces.

The use of the TCE 5 µg/L groundwater concentration as defining the extent of the Vapor Intrusion Evaluation Study Area is reasonable, supported by use of EPA's vapor intrusion screening level calculator, the generic default groundwater-to-indoor air attenuation factor of 0.001 and the appropriate Henry's Law conversion, empirical data, and mathematical modeling.

Work Plans shall be prepared or revised, as appropriate, to define the Vapor Intrusion Off-Property Study Area as the area bounded by the estimated TCE shallow zone groundwater contamination area greater than 5 µg/L. A comprehensive evaluation of the multiple lines of evidence collected for each site should be used in determining the potential for vapor intrusion at particular buildings and whether additional investigation and response actions are warranted. Any proposal to exclude particular buildings from indoor air sampling must be supported by a robust, site- and building-specific multiple-lines-of-evidence analysis.

Where contaminants other than TCE drive the vapor intrusion investigation, a site-specific and contaminant-specific analysis following the multiple-lines-of-evidence approach should be used to derive a sufficiently health protective study boundary for the vapor intrusion evaluation.

EPA supports a phased multiple-lines-of-evidence approach in prioritizing vapor intrusion investigations, for example: (1) colder weather indoor air sampling event and commercial building HVAC-off and HVAC-on sampling within the original Off-Property Study Area; (2) data evaluation and identification of data gaps, with subsequent additional multiple-lines-of-evidence data collection and analysis; (3) targeted step-out's to specific commercial/residential buildings or streets overlying lower contaminant concentration contour lines; and finally (4) full step-out and building-specific evaluation to off-property vapor intrusion study boundary line, or 5 µg/L for TCE.